JACKSON
DECLARATION

JACKSON DECLARATION

Before the
Federal Communications Commission
Washington, DC 20554

In the Matter of	)	
	)	
Implementation of the Local Competition Provisions in the Telecommunications Act of 1996	)	CC Docket No. 96-98
	)	
	)	

Declaration of Dr. Charles L. Jackson

1. My name is Charles L. Jackson. I am a director in the consulting firm LECG, Inc., which has offices at 1600 M Street, Washington, DC. I received my undergraduate degree in applied mathematics, with honors, from Harvard College in 1966. I received an M.S. from Massachusetts Institute of Technology (MIT) in 1974 and a Ph.D. in Electrical Engineering from MIT in 1977. I have worked for more than 30 years in the electronics and communications industry. A copy of my full biography is attached and incorporated herein by reference.

Introduction and Summary

2. The purpose of my declaration is to examine the alternatives for switching and interoffice transmission available to new entrants into the local exchange business. First, I describe alternative switching machines and transmission facilities that are already deployed by new entrants in many areas. Local carriers can and do use switches located at significant distances from their customers and provide them with competitive local telephone

service.[1] Second, I examine alternatives for interoffice transport and that connection of competitive local exchange carrier (CLEC) fiber to a specific incumbent local exchange carrier (ILEC) central office provides an alternative fiber route to all other ILEC central offices that are also connected to CLEC fiber.

Switching

3. In telecommunications, switches allow us to make more efficient use of transmission facilities — and vice versa. Historically, the expense of signal transmission and the degradation of signals as they were transmitted over long distances, led to a world in which switches were located relatively close to the end users they served. In the last several years, new technologies have broken those geographic limits on the area served by switches. For more than two decades, telecommunications circuit switches have been able to connect directly to signal formats containing multiple voice signals such as a DS-1—formatted signal carrying 24 digital voice channels. Those capacities were developed, in part, to support systems such as digital loop carrier systems that use high-capacity digital links out to remote terminals to economize on the cost of loops to telephone subscribers. Voice signals in digital formats, such as the DS-1 format, can be transmitted long distances without significant degradation. The combination of these two elements (digital line interfaces on switches and digital transmission) give modern telecommunications switches the capability to serve terminals located at long distances — many hundreds of miles — from the switch.

4. We can get some hints about the feasibility of operating a switch to serve users dispersed over a large geographic area from the marketing materials of the switch-manufacturers and of the carriers. For example, Lucent describes its equipment saying:

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[1] The use of switches located at long distances from the consumer is not the unique province of LECs. Most notably, call-back operators often use switches in one country to switch calls travelling between two other countries. Switches for wireless telephony are also often used to serve cells located at great distances from the switch. I discuss the wireless case further below.

> Also, remote switch modules can be located up to 600 miles from the host switch, making it easy to enter new territories.[2]

Lucent also says,

> The AnyMedia Access Interface Units (AIUs) are a global set of line side products that interface with Lucent's 5ESS Switch. The AIUs enable service providers to increase the capacity or services offered from a 5ESS, expand the reach of a 5ESS, or to quickly provide services in a new geographic location from an existing 5ESS.[3]
>
> The AnyMedia EAIU features the same functionality of the AIU, plus added flexibility. It services remote locations, allowing you to expand your network capabilities up to 2000 miles from the host central office. Like the AIU, the EAIU has the capacity to handle POTS, ISDN, Coin and ADSL while dramatically decreasing floor space needs and reducing power consumption.[4]

5. Nortel makes similar claims.

> Using a highly reliable and economical *counter-rotating ring* architecture, FDS-1 extends services from DMS-family switches that provide local access (the DMS-10, DMS-100, and DMS-500), S/DMS AccessNode, and other remote access vehicles to areas that could not be served cost effectively in the past. The ring can be up to 150 miles (240 kilometers) round trip, for maximum extension of up to 75 miles (120 kilometers) from the central office. The counter-rotating topology provides survivability, scalability, high capacity, route diversity, and interruption-free maintenance. Only two fibers are required for full redundancy, greatly reducing fiber costs.[5]
>
> (emphasis in original)

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2 http://www.lucent-sas.com/switching/switch.shtml.

3 http://www.lucent-sas.com/access/swaius.shtm.

4 Lucent, *AnyMedia Access Interface Units*, Product Brochure, 6 pages, April, 1999.

5 Nortel, 56056.16/1-96 Issue 1, S/DMS AccessNode Fiber Distribution System-1

Below is a diagram of that Nortel system.

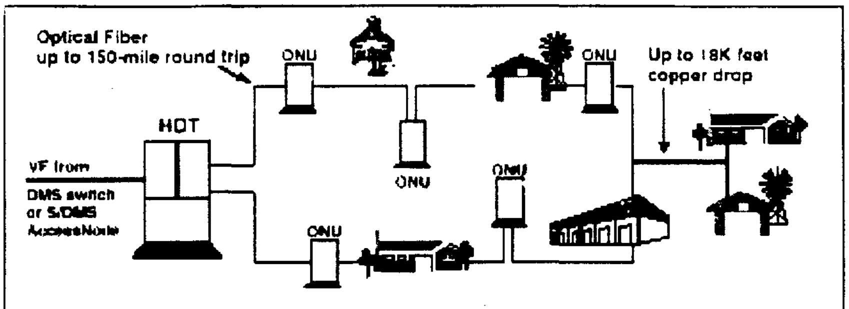

Figure 1. With a fiber ring of up to 150 miles, FDS-1 lets providers reach schools, farms, strip malls, and other subscribers in low line-size areas.

Figure 1. Nortel FDS-1 Diagram.

6. Similarly, in a document titled *High-Speed Access Business Case*, Nortel provides an outline of the analysis a firm would need in deciding whether to become a CLEC. One assumption in that analysis is "Remote sites must be within 500 miles of host switch."[6]

7. A Nortel system planning document describes their Star Remote System.

> This compact module provides a smaller, more cost-effective way to deliver DMS services across a very broad geographical area (up to 650 miles with no more than a 13-millisecond roundtrip delay between host and subscriber) into low-density areas, offices, or apartment buildings. For example, a 500-line Hub frame can serve DMS Meridian Digital Centrex services to a mid-sized business in a neighboring city, while up to ten Star Remote Modules extend the Centrex group services to locations hundreds of miles away in another state.[7]

8. Below is a system diagram of the Nortel Star Remote that shows both the hub and the remote modules.

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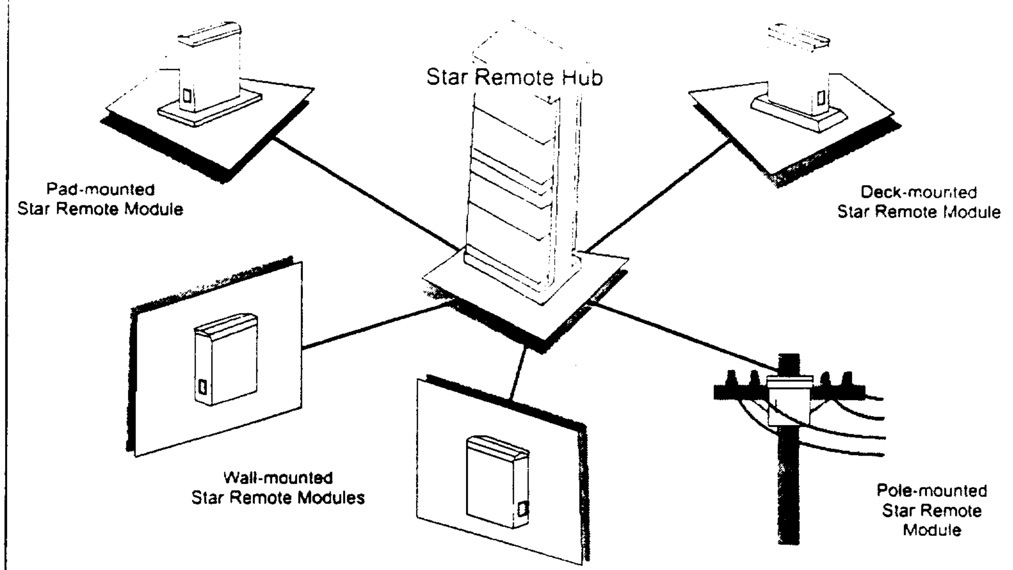
6 Nortel ISP Partner Program, *High Speed Access Business Case*, http://www1.nortelnetworks.com/pcn/isp/resource/bchisped.htm.

7 *Guide Update 1999 Dms-100/200 Supernode System Feature Planning*, Nortel, p. 138.



The Star Remote System's "Star" Configuration:
Star Remote Hub and up to 16 Star Remote Modules

Figure 2. Nortel Star Remote — Service up to 650 Mile Separation.

Using the Star Remote, a CLEC could offer service to users in several states and serve those loops from a switch 500 miles away.

9. In addition to such manufacturer's claims, I am aware of several instances in which carriers have used switches located many tens or hundreds of miles from the user location to provide service. For example, Cox Associates is a consulting firm that specializes in the application of operations research — including optimal network design — to industrial problems, including the design of wireless networks. Figure 3 below is taken from Cox Associates promotional literature. It shows the optimized version of a mobile network serving southern California. Notice that the area served by a single switch (Mobile Switching Office or MSO) in this figure stretches from Ventura in the North to

Tijuana in the South — a distance of more than 200 miles — and to Imperial in the East — about 300 miles from Ventura.[8] The large M denotes the MSO and the Hs denote intermediate hubs.

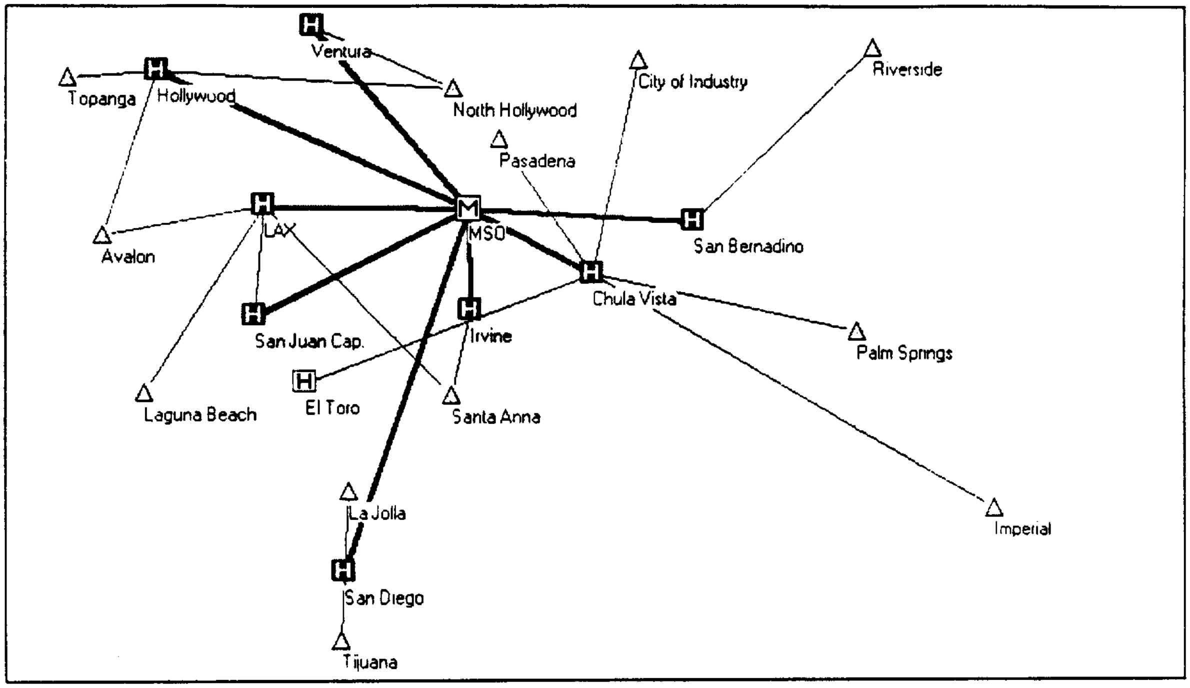


Figure 3. Cox Associates Diagram of a Cost-Optimized Mobile Network.

10. AirTouch's cellular operations in Michigan provide a specific example of switches serving wide areas. AirTouch provides service in seven cellular market areas in Michigan covering 21 counties. All of AirTouch's cellular switches are located in the Detroit area (four in Oakland County and two in Wayne County). Cellular traffic is backhauled from western Michigan cities such as Benton Harbor, Grand Rapids, or Muskegon to the switches in Detroit. Figure 4, taken from a recent AirTouch filing before the Michigan

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8 The Cox Associates paper is available at http://www.cox-associates.com/NetOpt.htm. Some of the surprising routings (e.g., Pasadena to Chula Vista to LA MSO) are due to the fact that capacity comes in discrete DS-3 chunks and it may be more cost effective to haul traffic in the apparently wrong direction if there is an otherwise empty pipe available to carry the traffic.

Public Service Commission, shows the AirTouch service area in Michigan and northern Ohio and the location of the AirTouch switches.[9] Cities in the AirTouch service area are at significant distances from Denver. Muskegon is about 175 miles from Detroit. Grand Rapids is about 140 miles from Detroit and Bay City is about 100 miles north of Detroit. One would expect that AirTouch is being rational about network operating costs. The clustering of switches produces many benefits. For example, maintenance technicians can work on any of the six switches without travelling a substantial distance. Spares can be pooled — with a reduced inventory of spares providing the capability for rapid repair in time of failure.

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[9] Petition of AirTouch Cellular, Inc. for Arbitration to Establish an Interconnection Agreement, Case No. U-11973, April 29, 1999, Appendix I. The cellular service area outlined on the map in Appendix I has been shaded in Figure 4.

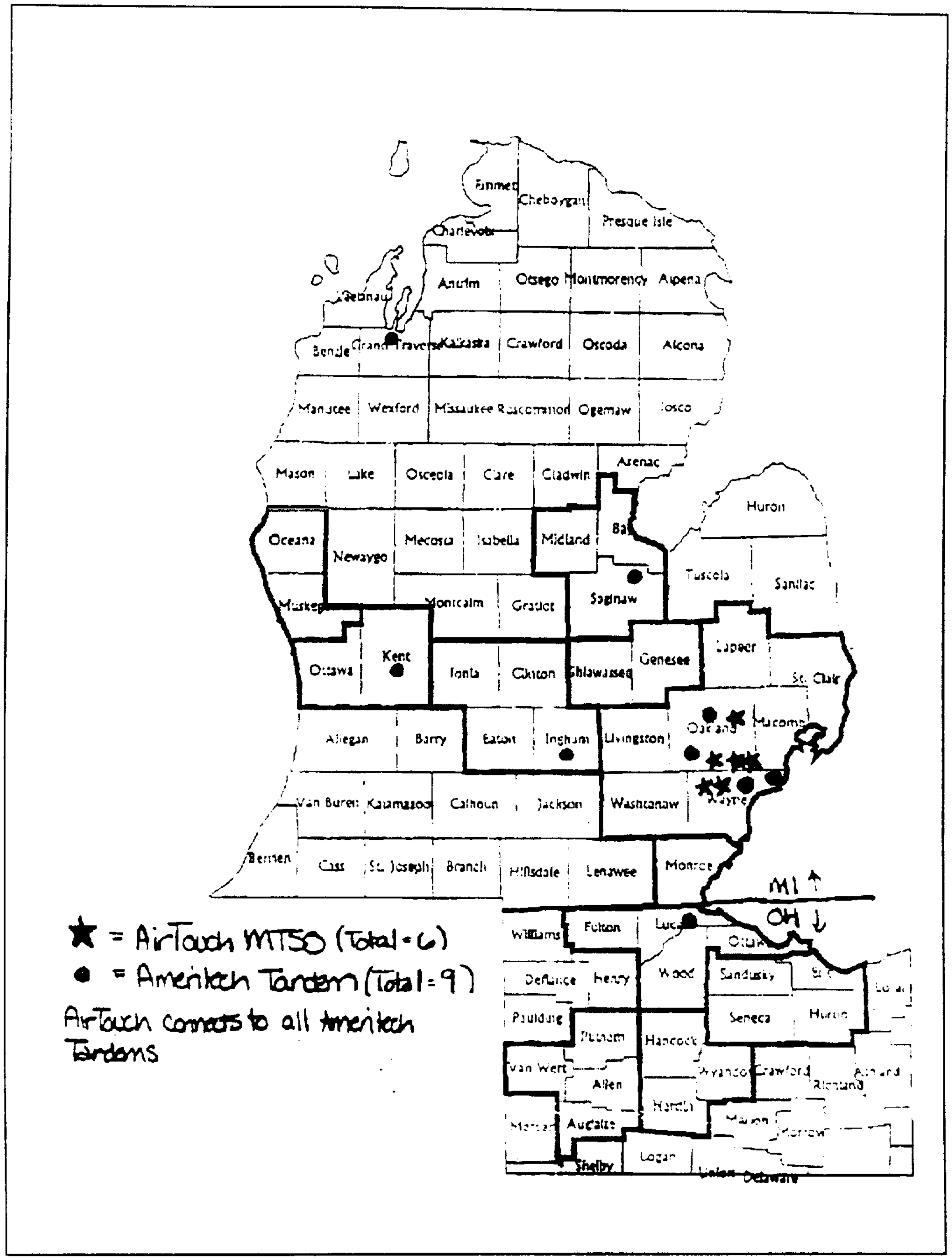

Figure 4. AirTouch Service Area and Switches Locations in Michigan.

11. AirTouch has stated that the use of cellular switches to serve multistate areas is valuable and will grow. In a presentation to the FCC on May 2, 1996, AirTouch said, "The number of multi-state CMRS systems served by a single MTSO will soon increase with the deployment of PCS Systems designed to accommodate multi-state MTSOs." AirTouch went on to say that switches restricted to serving only a single state could, under certain circumstances, be impractical and grossly inefficient.[10]

12. Once it became economical for switches to serve wide areas, switch manufacturers changed the switch software to remove restraints on the area that could be served by a switch. For example, Nortel system documentation describes one such system upgrade.

> This enhancement expands the Directory Number Inventory (DNINV) table to support the spread of directory numbers over all the possible 8171 NPA/NXX combinations in a DMS-100 SuperNode system. Such an expansion addresses Competitive Local Exchange Carrier (CLEC) table exhaust issues — calculated to be possible for large offices spanning multiple NPA/NXX combinations (say, in a regional switch deployment scheme) — that result in numerous discontinuous directory numbers.[11]

13. This example is particularly interesting because in this case Nortel modified its software to permit a CLEC to be able to use a single switch to serve customers in every area code/local exchange combination (NPA/NXX). Nortel saw a market need to respond to what it called *regional switch deployment schemes*. That is, Nortel is building switch software to support the wide serving areas that CLEC switches cover.

14. Other similar upgrades to switch software have occurred as well. For example, classes of service can now be assigned based upon the full 10-digit telephone number, not just the

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[10] AirTouch presentation in CC Docket 95-198 and 96-98, Kathleen Abernathy and Thomas Krattenmaker, May 2, 1996.

[11] *Guide Update 1999 Dms-100/200 Supernode System Feature Planning*, Nortel, p. 157.

7-digit number. This allows a CLEC to provide call waiting for the customer with telephone number 678-1234 in Des Moines but not to the customer with telephone number 678-1234 in Kansas City.

15. Backhauling traffic to a distant CLEC self-provided switch also has several other operational advantages. The CLEC has complete control of the programming and setup of such a switch. The CLEC can thus ensure that the switch provides the full range of services that the CLEC wishes to offer and that those features are implemented in a consistent fashion for all consumers. Such consistency simplifies product promotion, administration, and technical support — thereby lowering costs.

16. The CLECs typically install fiber rings serving a city or urban area and then locate a switch on that ring or haul the traffic from that ring back to another city to be switched. This CLEC behavior shows that the tradeoff between switching and transmission has altered radically in favor of transmission.

17. The larger CLEC firms (AT&T, MCI WorldCom) have switching capabilities and efficient networks for the backhaul function that they could use either for the self-provision of switching capacity or to provide switching services to others. Modern switches, for example, the Nortel DMS 500 or the Lucent 5ESS-2000 can carry both local and long-distance traffic. New entrants can use a single switch to serve an entire region (urban area, state, multistate region) or to enter into a new market region without physically installing a switch in that region. A CLEC could install a switch in Atlanta and provide service through much of the southeastern U.S. If the CLEC's traffic in Florida grew, it could install a second switch in Miami or Tampa.

Interoffice Transport

18. The fiber networks built by competitors provide alternatives to the incumbent LEC's interoffice transport facilities. When CLEC fiber or microwave connects to an ILEC central office, then interoffice transmission services to all other ILEC central office locations also connected to CLEC fiber or microwave have competitive alternatives. Consider Figure 5, which represents the locations of the ILEC central offices in a hypothetical community.

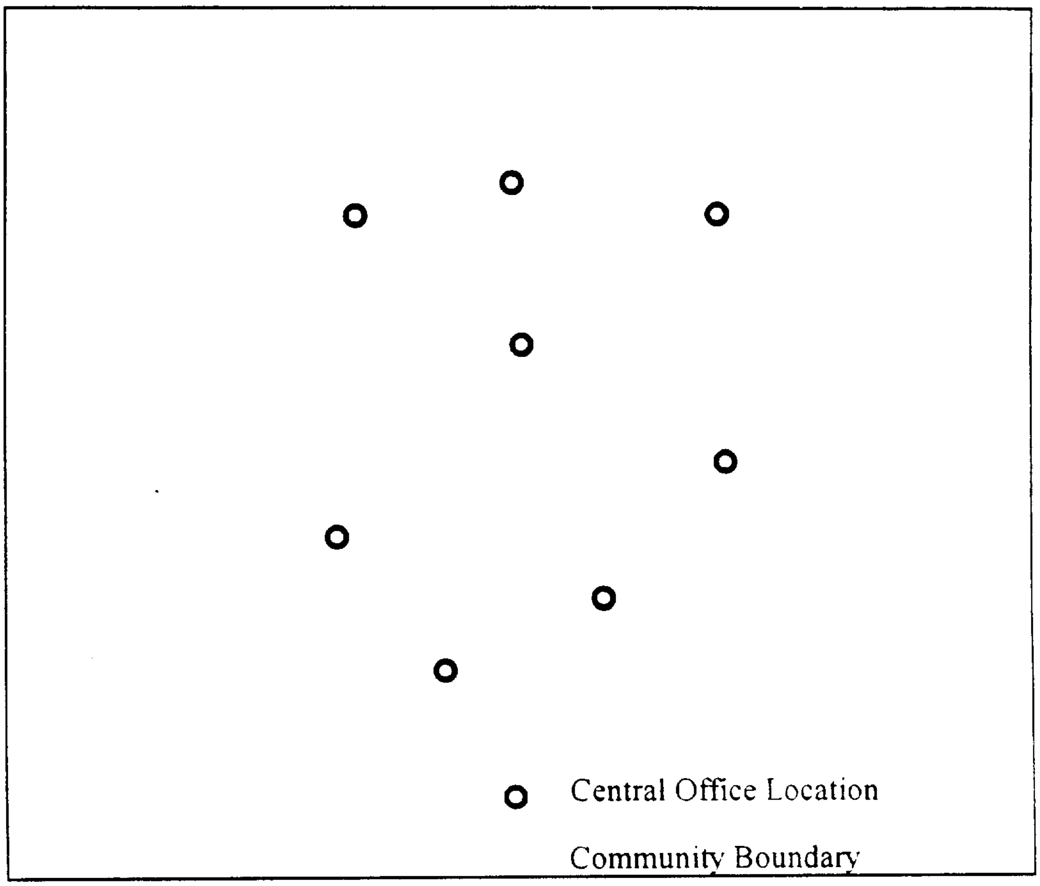

Figure 5. Community Boundaries and ILEC Central Office Locations.

19. Clearly, the ILEC must have a mechanism for moving traffic from each of these offices to all of the other offices. One approach to doing that is illustrated in Figure 7 as a pair of

hypothetical SONET rings with a traffic exchange point at one of the central office locations.

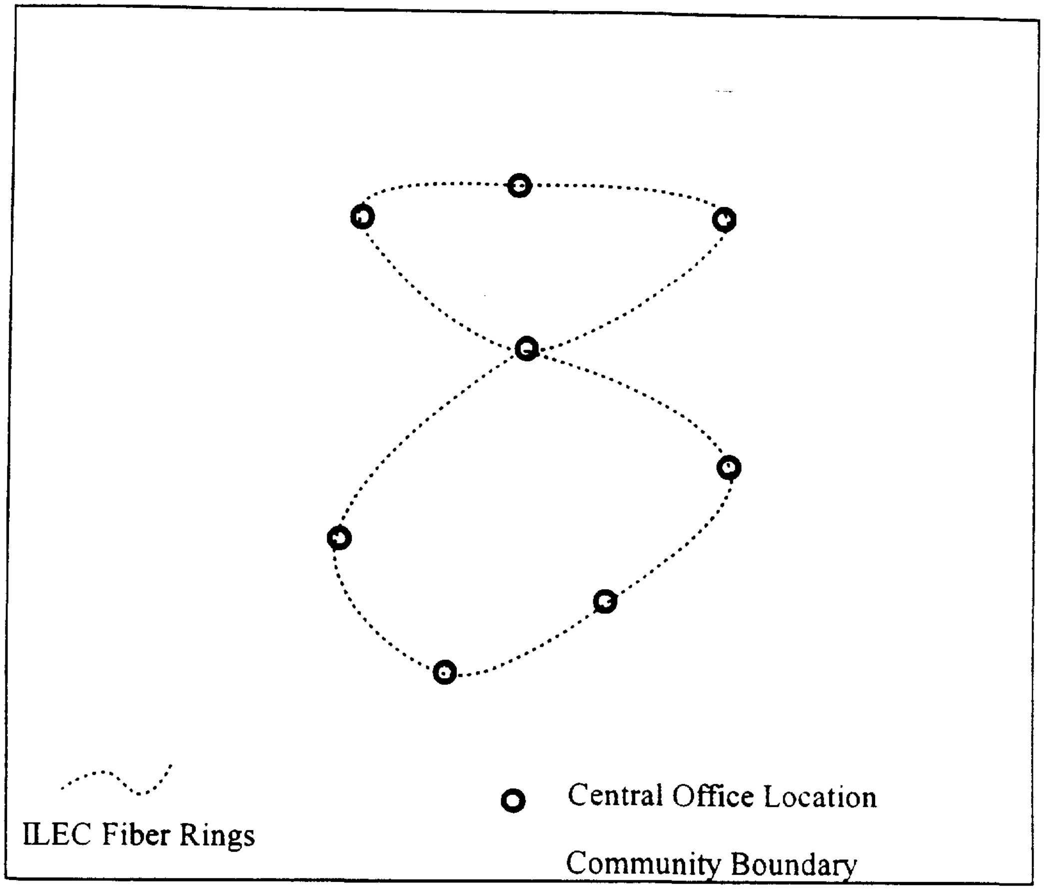

Figure 6. ILEC Central Offices and Fiber Rings.

20. A CLEC might also build a fiber facility serving the same community and connecting to some of the ILEC central offices as shown in Figure 8.

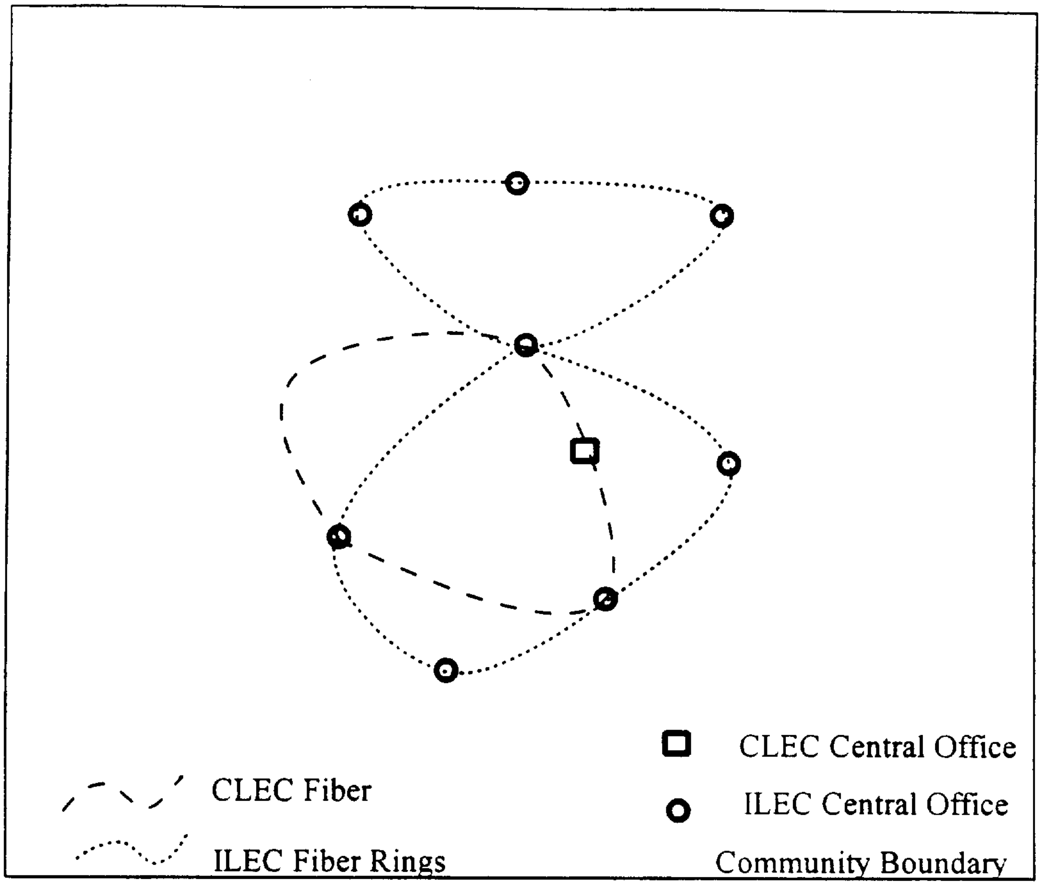

Figure 7. ILEC and CLEC Fiber Connections.

21. If a second CLEC also builds a network in the community, it is virtually certain that there will be a non-ILEC route between the networks of the two CLECs. For example, it is highly likely that both CLECs will connect to an AT&T point-of-presence (POP). In many communities, there are locations where the facilities of several telecommunications carriers come together.[12] It is natural for CLECs to connect to such nodal points. The network with two CLECs is shown in Figure 8.

[12] One particularly well known such location is 60 Hudson Street in New York City. See http://www.x-changemag.com/articles/941bigd.html.

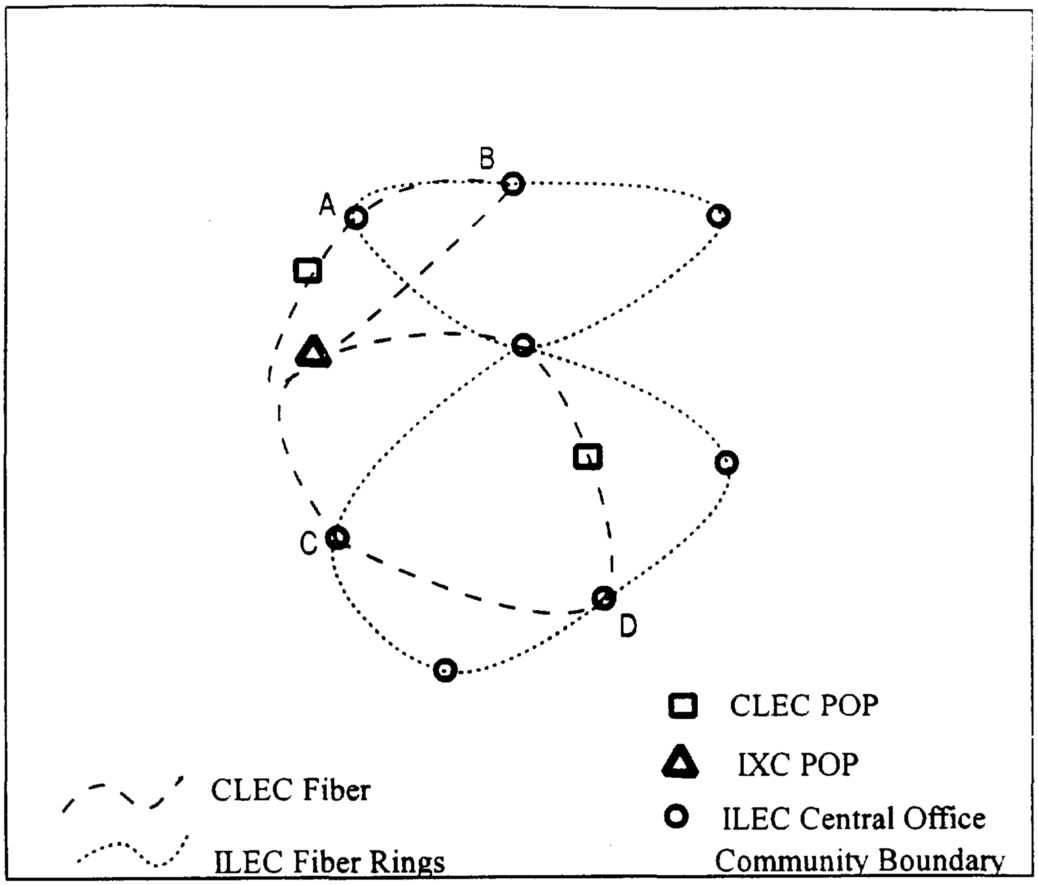

Figure 8. ILEC and CLEC Fiber Connections — Two CLECs.

22. Clearly, there are alternatives to the ILEC interoffice transmission facilities on the A-B and C-D routes. But, because the CLEC networks can be interconnected, the CLEC networks also create alternatives to the ILEC interoffice facilities on routes A-C, A-D, B-C, and B-D.

23. Another way to look at this connectivity is to consider alternative connectivity as a cloud — just as we consider the PSTN or the Internet to be a cloud. Whenever a central office is reached by a CLEC facility, then it is connected to the alternative connectivity cloud and there is an alternative route (alternative to the ILEC route) to all other ILEC central offices connected to the cloud. Figure 9 illustrates the growth of this cloud in the

hypothetical community considered above. It shows the same connectivity as in Figure 8 — but the connectivity is shown as a cloud rather than as individual links.

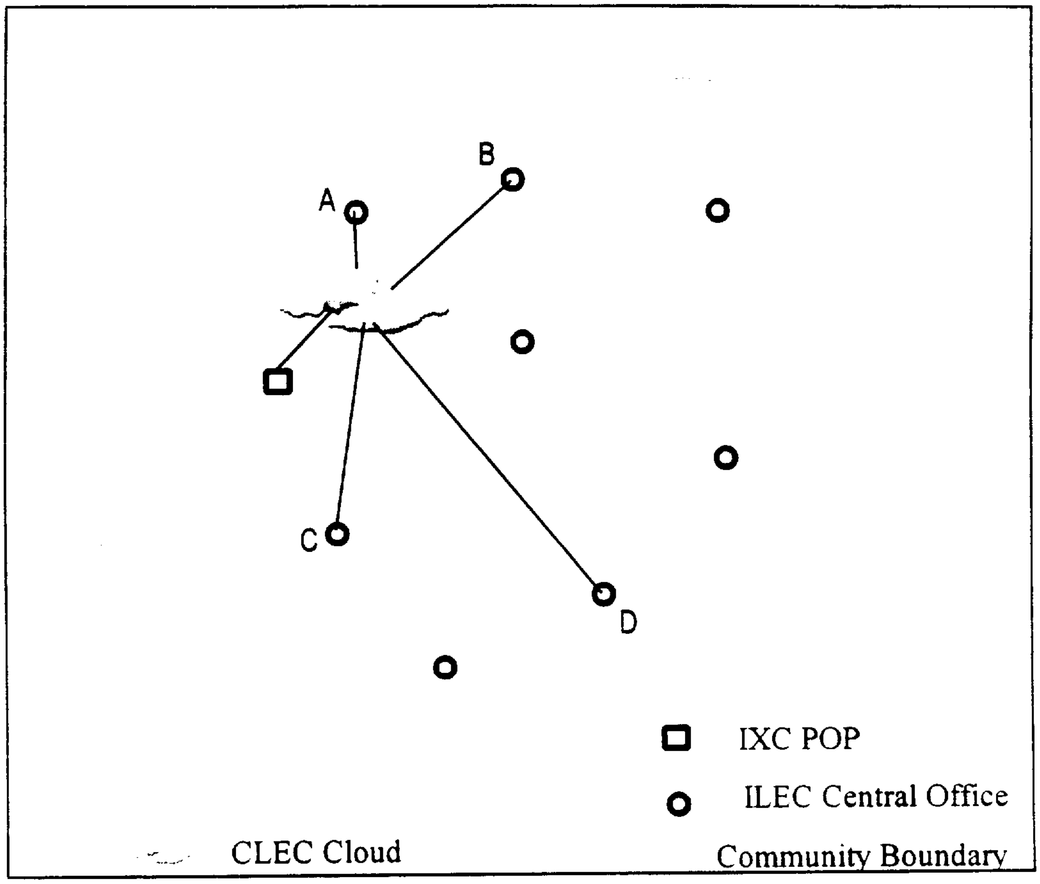

Figure 9. Cloud Representation of CLEC Connectivity.

24. As CLEC fiber reaches more and more ILEC central offices, the cloud of CLEC connectivity grows as shown in Figure 10:

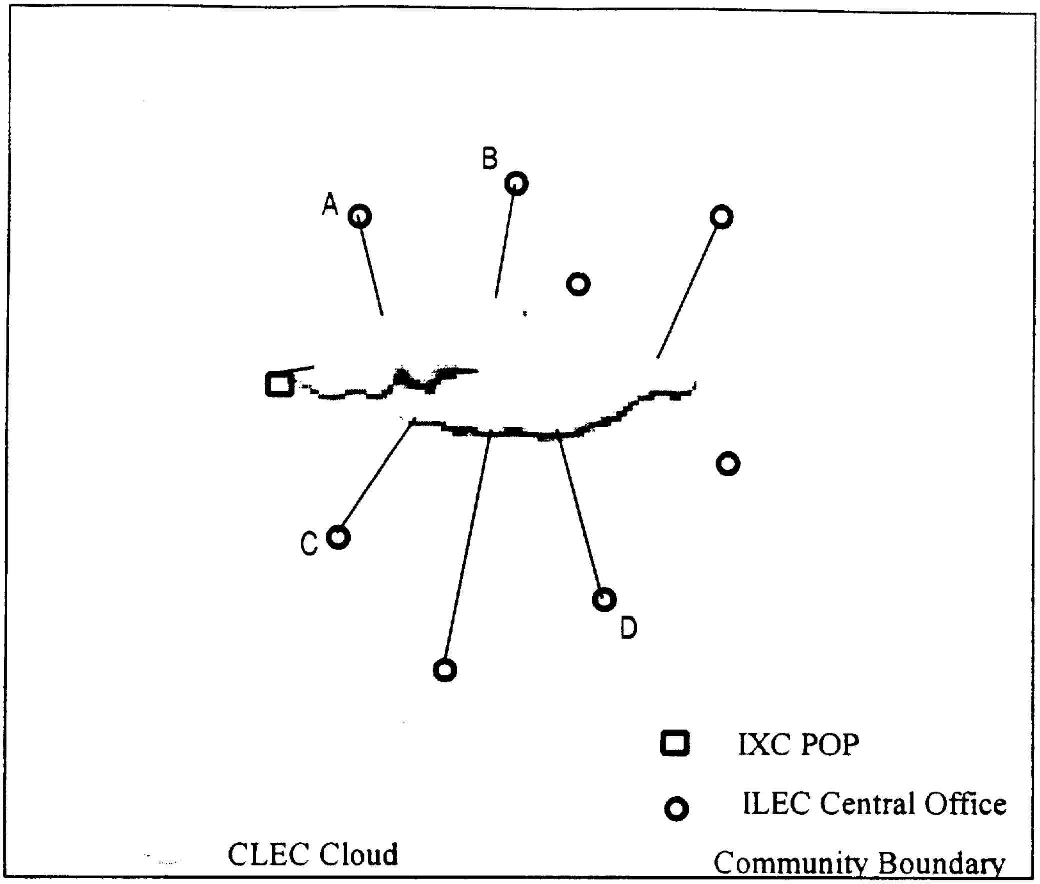

Figure 10. Growth of the Connectivity of the CLEC Cloud.

25. To recapitulate, when CLEC fiber touches a central office, alternatives appear for the interoffice routes to all the other ILEC central offices touched by CLEC fiber.

26. In the above discussion, I focused on fiber connectivity. But, one should also consider the impacts of modern radio-based carriers. Radio carriers with area licenses, such as the DEMS and LMDS carriers, can quickly install transmission capacity whenever a line-of-sight path exists from their premises (or premises they have rights to use) to the served premises. WinStar, a radio carrier that characterizes its service as *wireless fiber* in describing the services it offers to other carriers, states,

> WinStar offers the same capability without digging up the streets. And **our Wireless Fiber service can be installed quickly**. All it takes is a pair of one-to two-foot diameter antennas aimed at each

> other atop roofs or in windows. These devices are then linked through a "hub-and-spoke" network to WinStar's own local switching center or to an existing fiber-optic network already in the ground.[13] (Emphasis added.)

27. The implication here is that any ILEC central office that is in line-of-sight of a radio carriers should also be regarded as being connected to the CLEC cloud. That is, where CLECs have the ability to quickly add transmission faciiities, such installations on such routes should be regarded as competitive alternatives.

Conclusions

28. Modern telecommunications switches and modern fiber optic transmission systems have greatly expanded the capability of communications systems. One of the expansions has been in the area that switches can serve. It is now commonplace for switches to serve customers located hundreds of miles from the switch. The fact that modern telecommunications switches can efficiently serve terminal equipment located at substantial distances from the switch gives CLECs two ways to obtain switching capabilities in addition to use of the facilities of the ILEC. A CLEC can backhaul traffic to a remote CLEC switch. Alternatively, a CLEC can purchase switching from another firm, such as AT&T or MCI WorldCom, that is positioned to efficiently backhaul traffic to its switches.

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[13] http://www.winstar.com/indexCarrServ.htm

29. Fiber optics, together with efficient interconnection capabilities such as add-drop multiplexers, makes it economical for carriers to share capacity. Whenever a CLEC connects to an ILEC central office, that ILEC central office is connected to the entire cloud of alternate connectivity. Therefore, there are alternatives to the interoffice facilities offered by the ILEC to all of the other ILEC central offices also connected to the cloud of alternate connectivity.

I hereby declare, under penalty of perjury, that the foregoing is true and correct to the best of my knowledge and belief.

Charles L. Jackson

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May 26, 1999

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Dr. Jackson received a B.A. degree from Harvard College with honors in applied mathematics and M.S., E.E., and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology. At MIT, he specialized in operations research, computer science, and communications. While a graduate student at MIT, he held the faculty rank of Instructor, taught graduate operations research courses, and was codeveloper of an undergraduate course in telecommunications.

Before associating with LECG, Dr. Jackson was staff engineer for the Communications Subcommittee of the U.S. House of Representatives. At the Federal Communications Commission, he was special assistant to the Chief of the Common Carrier Bureau and engineering assistant to Commissioner Robinson. He has also worked as a digital designer and computer programmer. After leaving government, Dr. Jackson cofounded both the telecommunications consulting firm of Shooshan & Jackson Inc., whose practice was later combined with that of National Economic Research Associates, Inc., and Strategic Policy Research, Inc.

Dr. Jackson has served as an expert witness in litigation on cellular telephony, cable television, and other telecommunications and computer issues and has testified before several state utility commissions.

He has authored or coauthored numerous studies on public policy issues in telecommunications and has testified before Congress on technology and telecommunications policy. Over the last several years, he has also directed or participated in projects on acquisition analysis, market planning, and product pricing. He has written for professional journals and the general press, with articles appearing in publications ranging from *The IEEE Transactions on Computers* to *Scientific American* to *The St. Petersburg Times*. He holds a U.S. patent on an alarm signaling system.

Dr. Jackson is a member of the IEEE, the Internet Society, the American Mathematical Society, and Sigma Xi. He is an adjunct professor of electrical engineering and computer science at George Washington University, where he teaches a graduate course in mobile communications. From 1982 to 1988, he was an adjunct professor at Duke University. He is a member of of the U.S. Department of Commerce's Spectrum Planning and Policy Advisory Committee (SPAC) and of the Federal Communications Commission's Technological Advisory Committee.

EDUCATION

Massachusetts Institute of Technology
Ph.D., Communications and Operations Research, 1977
M.S. and E.E., Electrical Engineering, 1974

Harvard College
B.A., Honors in Applied Mathematics, 1966

EMPLOYMENT

Currently	**Law and Economics Consulting Group.** (LECG), Washington, DC, **Director**
	Strategic Policy Research, Inc. (SPR), Bethesda, MD
1992–1997	**Principal.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.
	National Economic Research Associates, Inc. (NERA), Washington, DC
1989–1992	**Vice President.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.
	Shooshan & Jackson Inc., Washington, DC
1980–1988	**Principal.** Provided telecommunications and public policy consulting services for a variety of clients in the telecommunications industry.
	Communications Subcommittee, U.S. House of Representatives, Washington, DC
1977–1980	**Staff Engineer**. Was responsible for common carrier legislation and spectrum-related issues.
	Common Carrier Bureau, Federal Communications Commission, Washington, DC
1976–1977	**Special Assistant to Chief**. Was responsible for technological issues and land mobile policy.
	Federal Communications Commission, Washington, DC
1975–1976	**Engineering Assistant to Commissioner Robinson.**
	CNR, INC., Boston, MA
1973–1976	**Consultant.** Worked on the implementation of digital communication systems over dispersive channels.
	Massachusetts Institute of Technology, Cambridge, MA
1973–1976	**Instructor.**
1971–1973	**Research and Teaching Assistant.**

Signatron, Lexington, MA

1968–1971 **Research Engineer.**

Stanford Research Institute, Menlo Park, CA

1966–1968 **Programmer.**

PROFESSIONAL ACTIVITIES

Member, Sigma XI, Institute of Electrical and Electronics Engineers (IEEE), IEEE Computer Society, IEEE Communications Society, IEEE Information Theory Society, American Association for the Advancement of Science, the Internet Society, and the American Mathematical Society.

From 1987–88, served on the Board of Directors of the Telecommunications Policy and Research Conference. Chairman of the Board, 1988.

Chairman, IS/WP1 (Policy and Regulation) of the FCC's Advisory Committee on Advanced Television.

Executive Committee Member, University of Florida's Public Utility Research Center (PURC).

Member, U.S. Department of Commerce Spectrum Planning and Policy Advisory Committee.

Member, Federal Communications Commission Technological Advisory Committee.

TESTIMONIES

Statement of Dr. Charles L. Jackson before the Federal Communications Commission En Banc Hearing on Spectrum Management.

Declaration of Dr. Charles L. Jackson before the FCC in *1998 Biennial Regulatory Review — Spectrum Aggregation Limits for Wireless Telecommunications Carriers, WT Docket No. 98-205*, Prepared for Bell Atlantic. January 25, 1999.

Testimony of Charles L. Jackson, in re: *GWI PCS1, Inc., at al., Debtors and GWI PCS1, Inc., et al., Plaintiffs vs. Federal Communications Commission, Defendant,* in United States Bankruptcy Court for the northern District of Texas, Dallas Division, April 16, 1998.

Preliminary Statement of Dr. Charles Jackson, in *Amarillo CellTelCo v. Southwestern Bell Wireless, Inc. et al.* in United States District Court, Northern District of Texas, Amarillo Division, March 27, 1998.

Deposition of Charles L. Jackson, in re: *GWI PCS I, Inc., at al., Debtors and GWI PCS I, Inc., et al., Plaintiffs vs. Federal Communications Commission, Defendant,* in United States Bankruptcy Court for the northern District of Texas, Dallas Division, March 19, 1998.

Declaration of Charles L. Jackson, Prepared in the United States Court for Federal Claims for Plaintiff CellularOne in *Washington Baltimore Cellular Limited Partnership (d/b/a CellularOne Washington/Baltimore) Plaintiff, and Bell Atlantic Mobile, Inc. Intervenor-Plaintiff, v. United States, Defendant,* Case No. 98–50C (Judge Hodges), March 4, 1998.

Declaration of Charles L. Jackson, Prepared in the United States Court for Federal Claims for Plaintiff CellularOne in *Washington Baltimore Cellular Limited Partnership (d/b/a CellularOne Washington/Baltimore) Plaintiff, and Bell Atlantic Mobile, Inc. Intervenor-Plaintiff, v. United States, Defendant,* Case No. 98–50C (Judge Hodges), February 25, 1998.

Joint Rebuttal Statement of Charles L. Jackson and Jonathan L. Kramer, Expert report prepared for the defendants in *Playboy Entertainment Group, Inc. v. United States of America et al.,* Civil Action No. 96–94/96–107–JJF, January 1998.

Joint Statement of Charles L. Jackson and Jonathan L. Kramer, Expert report prepared for the defendants in *Playboy Entertainment Group, Inc. v. United States of America et al.,* Civil Action No. 96–94/96–107–JJF, December 3, 1997

Testimony filed before the Public Service Commission of Nevada on behalf of Nevada Bell, *In the Matter of The Petition of AT&T Communications of Nevada, Inc., for Arbitration Pursuant to Section 252(b) of the Federal Telecommunications Act of 1996 to Establish an Interconnection Agreement with Nevada Bell,* Docket 97–5014. June 12, 1997.

Testimony before the U.S. Senate Committee on Commerce, Science, and Transportation. Hearings on S.255, the Public Safety Telecommunications Act. May 15, 1997.

With Jeffrey H. Rohlfs and Ross M. Richardson. *The Depreciation Shortfall.* Prepared for submission before the Federal Communications Commission, CC Docket No. 96–262: *USTA Comments,* Attachment 15, filed January 29, 1997. *Reply Comments* filed February 13, 1997.

Reply Comments filed before the Federal Communications Commission on behalf of Ericsson Inc., *In the Matter of the Development of Operational, Technical, and Spectrum Requirements for Meeting Federal, State, and Local Public Safety Agency Communication Requirements Through the Year 2010,* WT Docket No. 96–86. December 19, 1996.

Testimony filed before the Public Utilities Commission of the State of California on behalf of Pacific Bell. *In the Matter of Application of MCI Telecommunications Corporation for Arbitration Pursuant to Section 252 of the Federal Telecommunications Act of 1996 to Establish an Interconnection Agreement with Pacific Bell,* Application No. 96–08–068. September 24, 1996.

Reply testimony filed before the Public Utilities Commission of the State of California on behalf of Pacific Bell. *Rulemaking on the Commission's Own Motion to Govern Open Access to Bottleneck Services and Establish a Framework for Network Architecture Development of Dominant Carrier Networks.* R.93–04–003. *Investigation on the Commission's Own Motion into Open Access and Network Architecture Development of Do ninant Carrier Networks.* I.93–04–002. July 10, 1996.

Declaration filed before the Federal Communications Commission on behalf of the United States Telephone Association. *In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, CC Docket No. 96–98. May 16, 1996.

Declaration filed before the Federal Communications Commission on behalf of Bell Atlantic Network Services, Inc., *In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, CC Docket No. 96–98. May 15, 1996.

Testimonial declaration filed before the United States District Court for the District of Delaware on behalf of the United States Department of Justice, *Playboy Entertainment Group, Inc., and Graff Pay-Per-View, Inc., v. United States of America, et al.*, Civil Action No. 96–94/96–107–JJF, Consolidated Action. May 13, 1996.

Remarks on spectrum policy before the Federal Communications Commission *en banc* hearing. March 5, 1996.

Affidavit filed before the Federal Communications Commission on behalf of The Wireless Communications Council, *In the Matter of Omnipoint Communications, Inc. New York MTA Frequency Block A*, File No. 15002–CW–L–94. January 16, 1996.

Testimony filed before the Public Service Commission of South Carolina on behalf of Southern Bell Telephone and Telegraph Company, *BellSouth Telecommunications, Inc. d/b/a Southern Bell Telephone and Telegraph Company Request for Approval of the Consumer Price Protection Plan in South Carolina*, Docket No. 95–720–C. September 1995.

Testimony before the Subcommittee on Telecommunications and Finance of the Committee on Commerce, U.S. House of Representatives. Hearings on Federal Management of the Radio Spectrum. September 7, 1995.

With Dale N. Hatfield. Testimony before the U.S. Senate Committee on Commerce, Science and Transportation. Hearings on radio spectrum issues. July 27, 1995.

Testimony in *Turner Broadcasting System, Inc., et al., Plaintiffs, v. Federal Communications Commission, et al., Defendants.* United States District Court for the District of Columbia. Docket No. C.A. No. 92–2247 (and related cases C.A. Nos. 92–2292, 92–2494, 92–2495, 92–2558) (TPJ). Expert's Report filed April 21, 1995; Expert Declaration filed May 25, 1995.

Testimony filed before the Public Service Commission of the District of Columbia on behalf of Bell Atlantic–Washington, D.C., Inc., Formal Case No. 814, Phase IV. January 31, 1995. Rebuttal testimony filed before the Public Service Commission of the District of Columbia. September 15, 1995.

Testimony filed before the State of North Carolina Utilities Commission on behalf of Sprint Mid-Atlantic Telecom, *In the Matter of Investigation to Consider Implementation of a Plan for Intrastate Access Charges for all Telephone Companies Under the Jurisdiction of the North Carolina Utilities Commission and Investigation into Defined Radius Discount Calling Plans*. Docket No. P–100, Sub. 65 and Docket No. P–100, Sub 126. April 1994.

Testimony filed before the Commonwealth of Kentucky before the Public Service Commission on behalf of South Central Bell Telephone Company, *In the Matter of Application of BellSouth Telecommunications, Inc. d/b/a South Central Bell Telephone Company to Modify its Method of Regulation*, Case No. 94–121. April 1994.

Testimony filed before the Federal Communications Commission on behalf of Bell Atlantic, *In the Matter of The Bell Atlantic Telephone Companies Tariff FCC No. 10–Video Dialtone Service*. March 6, 1995. Supplemental testimony filed before the Federal Communications Commission. December 20, 1995.

Expert statement on behalf of Bell Atlantic before the Court of Common Pleas, Philadelphia County, PA, September Term 1990, No. 775 re: *Shared Communications Services of 1800–80 JFK Boulevard, Inc. v. Bell Atlantic Properties, Inc. et al.* February 1995.

With Jeffrey H. Rohlfs. *Quantifying the Costs of Billed Party Preference*. Report filed before the Federal Communications Commission on behalf of American Public Communications Counsel, *In the Matter of Billed Party Preference for 0+ InterLATA Calls*, CC Docket No. 92–77. September 14, 1994.

With Jeffrey H. Rohlfs. *The Many Costs and Few Benefits of Billed Party Preference*. Report filed before the Federal Communications Commission on behalf of American Public Communications Counsel, *In the Matter of Billed Party Preference for 0+ InterLATA Calls*, CC Docket No. 92–77. August 1, 1994.

Testimony filed before the Georgia Public Service Commission on behalf of BellSouth Telecommunications, Inc., *In Re: Petition of BellSouth Telecommunications, Inc., d/b/a Southern Bell Telephone and Telegraph Company for Consideration and Approval of Georgians First*. June 22, 1994.

With Jeffrey H. Rohlfs. *Report on Capital Needs of a Telephone Company*. Direct and rebuttal testimony before the United States Tax Court, Dockets 7970–91 and 7971–91. June 1994. [Confidential]

Statement filed before the Public Service Commission of Maryland on behalf of Bell Atlantic–Maryland, Inc., in connection with Case No. 8587. June 10, 1994.

Surrebuttal testimony filed before the State Corporation Commission of Virginia on behalf of Bell Atlantic–Virginia, Inc., in connection with Case No. PUC930036. April 20, 1994.

Statement on personal communications service (PCS) before the Federal Communications Commission Personal Communications Services Task Force Meeting, Docket 90–314. April 12, 1994.

Sharing Spectrum Between PCS and Microwave Systems. White paper filed before the Federal Communications Commission on behalf of Bell Atlantic Personal Communications, Inc., in connection with General Docket No. 90–314; Bandwidth Required for PCS Licenses. August 1993.

Testimony filed before the Federal Communications Commission on behalf of Bell Atlantic Personal Communications, Inc., *In the Matter of the Amendment of the Commission's Rules to Establish New Personal Communications Services*, "Technical Considerations Regarding the 'Size' of PCS Licenses." November 1992.

Rebuttal testimony filed before the Public Service Commission of the District of Columbia on behalf of the Chesapeake and Potomac Telephone Company, Formal Case No. 814, Phase III. November 1992.

Testimony filed before the Public Service Commission of Maryland on behalf of the Chesapeake and Potomac Telephone Company of Maryland. *In the Matter of the Application of the Chesapeake and Potomac Telephone Company of Maryland to Continue and Revise the Alternative Regulation Plan and to Revise and Restructure its Rates and Charges*. Case No. 8462. May 1992.

Statement on personal communications systems (PCS) before the Federal Communications Commission *en banc* hearings. December 5, 1991.

Testimony on Depreciation before the State of Connecticut Department of Public Utility Control on behalf of the Southern New England Telephone Company. September 1990

Testimony on Private Line Alternatives before the Public Utilities Commission of the State of Colorado on behalf of the Mountain States Telephone and Telegraph Company. September 1987.

Testimony on *Open Network Architecture and Comparably Efficient Interconnection Policies* before the House Subcommittee on Telecommunications and Finance. U.S. House of Representatives. July 30, 1987.

Testimony on proposed Federal Communications Commission Auction Authority before the Telecommunications, Consumer Protection, and Finance Subcommittee. U.S. House of Representatives. October 28, 1986.

Testimony on the *Application of Southwestern Bell Telephone Company for a Rate Increase before the Public Service Commission of the State of Missouri* on behalf of Southwestern Bell Telephone Company. February 1986.

Rebuttal testimony on the *Application of Southwestern Bell Telephone Company for a Rate Increase before the Public Utility Commission of Texas* on behalf of Southwestern Bell Telephone Company. October 1985.

Testimony on S. 880 before the Committee on Commerce, Science and Transportation. U.S. Senate. April 4, 1984. ["Daytime Broadcasters"]

Testimony on S. 66 before the Subcommittee on Communications, Committee on Commerce, Science and Transportation, U.S. Senate. February 16, 1983. ["Bypassing Cable"]

Testimony on Freedom of Expression and the Electronic Media: Technology Issues before the Committee on Commerce, Science and Transportation, U.S. Senate. September 28, 1982.

Testimony on S. 2355 before the Subcommittee on Communications, Committee on Commerce, Science and Transportation, U.S. Senate. May 6, 1982.

Testimony on Electronic Mail before the Postal Operations and Service Subcommittee. U.S. House of Representatives. May 5, 1977.

PUBLICATIONS

With Robert W. Crandall. *Eliminating Barriers to DSL Service*. Prepared for Keep America Connected!, July 1998

With John Haring et al. "Public Harms Unique to Satellite Spectrum Auctions", chapter 17 in *A Communications Cornucopia: Markle Foundation Essays on Information Policy*, Roger G. Noll and Monroe E. Price, Eds., Brookings, 1998.

With John Haring and Ross Richardson. *An Evaluation of the Access Board's Accessibility Guidelines*. Prepared for the Telecommunications Industry Association, June, 1998.

With Robert W. Crandall. *The Internet, Economic Growth, and Telecommunications Policy: Charles H. Ferguson's Critique of U.S. Local Telephone Companies*. Prepared for Bell Atlantic for filing at the Federal Communications Commission. July 1997.

With John Haring et al. *Evaluation of the Efficiency of BT's Network Operations*. Prepared for The Office of Telecommunications, U.K. June 1997.

With John Haring. *Economic Disabilities of License Eligibility and Use Restrictions*. Prepared for Bell Atlantic. September 10, 1996.

With Calvin S. Monson and Ross M. Richardson. *Making California's Transition Work: The Need for Affordable and Reliable Electric Metering*. Prepared on behalf of Itron, Inc., for submission before the Public Utilities Commission of the State of California, Comments of Itron, Inc., upon "Design and Implementation of Direct Access Programs," a Report of the Direct Access Working Group, dated August 30, 1996, and issued in response to CPUC Decision 96–03–022 of March 13, 1996, in the *Order Instituting Rulemaking on the Commission's Proposed Policies Governing Restructuring California's Electric Services Industry and Reforming Regulation* (R.94–04–031) and *Order Instituting Investigation on the Commission's Proposed Policies Governing Restructuring California's Electric Services Industry and Reforming Regulation.* (I.94–04–032) Filed September 1996.

With John Haring, Jeffrey H. Rohlfs, and Harry M. Shooshan III. *The Benefits of Choosing: FCC Specification of an ATV Standard.* Prepared on behalf of Capital Cities/ABC, Inc., CBS, Inc., Fox Television Stations, Inc., the Association for Maximum Service Television, the National Association of Broadcasters and National Broadcasting Company, Inc., for submission before the Federal Communications Commission, *In the Matter of Advanced Television Systems and their Impact upon the Existing Television Broadcast Service.* MM Docket No. 87–268. *Reply Comments of Strategic Policy Research on the Commission's Fifth Further Notice of Proposed Rulemaking.* Filed August 13, 1996.

With John Haring. *Critique of Hatfield Cost Analysis.* Prepared on behalf of BellSouth for submission before the Federal Communications Commission, *In the Matter of Implementation of the Pay Telephone Reclassification and Compensation Provisions of the Telecommunications Act of 1996.* CC Docket No. 96–128. *Reply Comments.* Filed July 15, 1996.

With John Haring and Calvin S. Monson. *Economic Report on FCC Resolution of Payphone Regulatory Issues.* Prepared on behalf of BellSouth for submission before the Federal Communications Commission, *In the Matter of Implementation of the Pay Telephone Reclassification and Compensation Provisions of the Telecommunications Act of 1996.* CC Docket No. 96–128. *Comments.* Filed July 1, 1996.

With John Haring, Harry M. Shooshan III, Jeffrey H. Rohlfs, and Kirsten M. Pehrsson. *Public Harms Unique to Satellite Spectrum Auctions.* A study prepared for the Satellite Industry Association. March 18, 1996.

A Need to Be Heard: Will Project 25 Meet Public Safety Communications Needs in 1995 and Beyond? Prepared for Ericsson Radio. July 21, 1995.

With John Haring. *Pitfalls in the Economic Valuation of the Electromagnetic Spectrum.* Prepared for the National Association of Broadcasters. July 19, 1995.

With John Haring, Calvin S. Monson, Jeffrey H. Rohlfs, and Morrison & Foerster. *A Proposal for Introducing Competition into the Mexican Telecommunications Market.* Prepared for the Government of Mexico, Secretaria de Comunicaciones y Transportes. June 10, 1994.

With John Haring. *Errors in Hazlett's Analysis of Cellular Rents: An Elaboration.* Prepared for Bell Atlantic Personal Communications, Inc. for submission to the Federal Communications Commission in General Docket No. 90–314, *Bandwidth Required for PCS Licenses.* April 1994.

With John Haring. *Errors in Hazlett's Analysis of Cellular Rents.* Prepared for Bell Atlantic Personal Communications, Inc., for submission to the Federal Communications Commission in General Docket No. 90–314, *Bandwidth Required for PCS Licenses.* September 10, 1993.

Study of the Application of Open Network Provision to Network Management. Prepared for the CEC DGXIII jointly by NERA and Mondiale Information Technology Associates. January 1992. Final report, March 1992.

Study of Open Network Provision Applied to Network Management. Prepared for the CEC DGXIII jointly by NERA and Mondiale Information Technology Associates. January 1992.

"LEC Gateways: Provision of Audio, Video, and Text Services in the U.S." *The Economics of Information Networks*, Cristiano Antonelli, Ed., North-Holland/Elsevier Science Publishers B.V., Amsterdam, London, New York, Tokyo. 1992.

With Harry M. Shooshan III, Kirsten Pehrsson *et al.* *Electronic Highways: Providing the Telecommunications Infrastructure for Pennsylvania's Economic Future.* Prepared for the Pennsylvania Chamber of Business and Industry jointly by NERA and Price Waterhouse. December 19, 1991.

Competition in the Provision of Air-to-Ground Telephone Service. Prepared for In-Flight Phone Corporation. NERA. November 14, 1991.

With Jeffrey Rohlfs and Tracey Kelly. *Estimate of the Loss to the United States Caused by the FCC's Delay in Licensing Cellular Telecommunications.* A study commissioned by AT&T. November 8, 1991 (revised).

With others. *The Technology and Economics of Providing Video Services by Fiber Optic Networks: A Response to Johnson and Reed.* A study prepared for the United States Telephone Association. NERA. July 20, 1990.

With Robin Foster. *The New Zealand Spectrum Project: Description and Observations.* Presented to the Seventeenth Annual Telecommunications Policy Research Conference. Airlie, VA. October 1–3, 1989.

"Use and Management of the Spectrum Resource." *New Directions in Telecommunications Policy, Vol. 1: Regulatory Policy*, Paula R. Newberg, Ed., Duke Press Policy Studies, Duke University Press, Durham and London. 1989.

With Robin Foster *et al.* *Management of the Radio Frequency Spectrum in New Zealand.* Prepared for New Zealand's Ministry of Commerce. November 1988.

With Harry M. Shooshan III, Jeffrey H. Rohlfs, and Louise Arnheim. *Home Video Programming: How Secure from Piracy? A Comparison of VCRs, C-Band Satellite Service, Wireless Cable, Cable, and MDS.* Prepared for MetroTEN Cablevision. July 1988.

With Harry M. Shooshan III, Jeffrey H. Rohlfs, and Susan W. Leisner. *ONA: Keeping the Promise*. A study commissioned by Bell Atlantic. May 1988.

With Louise A. Arnheim. *A High-Fiber Diet For Television? Impact of Future Telephone, Fiber and Regulatory Changes for Broadcasters*. Prepared for the National Association of Broadcasters. April 1988.

With Harry M. Shooshan III, Jeffrey H. Rohlfs, and Louise A. Arnheim. *Opening the Broadband Gateway: The Need for Telephone Company Entry into the Video Services Marketplace*. Prepared for the United States Telephone Association. November 1987.

With Harry M. Shooshan III and Louise A. Arnheim. *Tough Calls, Close Calls, Protocols.* Prepared for BellSouth Corporation. August 1987.

With Catherine R. Sloan. *Federal Communications Regulation and Services to Handicapped Persons.* Prepared for the Gallaudet/Annenberg Forum on Policy Issues, Washington, DC. February 20–21, 1986.

"Cable and Public Utility Regulation." *Unnatural Monopolies*, Robert W. Poole, Jr., Ed., D. C. Heath & Company, Lexington, MA. 1985.

With Jeffrey H. Rohlfs. *Access Charging and Bypass Adoption.* Shooshan & Jackson. 1985.

"Technological Overview and Framework." *Telecommunications Access and Public Policy*, Alan Baughcum and Gerald R. Faulhaber, Eds., Proceedings of the Workshop on Local Access, St. Louis, MO. September 1982. Ablex Publishing Corporation, Norwood, NJ. 1984.

"Technology: The Anchor of the Bell System." *Disconnecting Bell: The Impact of the AT&T Divestiture*, Harry M. Shooshan III, Ed. (Institute for Information Policy), Pergamon Press, Elmsford, NY. 1984.

With Harry M. Shooshan III. *The Financial Interest and Syndication Rules: Public Harm and Consumer Loss*. Shooshan & Jackson. 1983.

With Harry M. Shooshan III. *Radio Subcarrier Services: How to Make Dollars and Sense out of New Business Opportunities*. COM/TECH Report. Vol. 2, No. 1. National Association of Broadcasters. May 1983.

New Technology: Some Observations on "Bypass." Presented to the Federal Communications Bar Association: PLI Program, Washington, DC. December 10, 1982.

Technological and Market Alternatives to Direct Regulation of Telephone Solicitation. Presented to the IEEE International Conference on Communications, Philadelphia, PA. June 13–17, 1982.

With Jane Wilson and Harry M. Shooshan III. *Alternative Methods of Extending Public Radio Service.* Prepared for the Corporation for Public Broadcasting. March 1982.

With Harry M. Shooshan III. *Cable Television: The Monopoly Myth and Competitive Reality.* Prepared for the National Cable Television Association. 1982.

With Harry M. Shooshan III, Stanley M. Besen, and Jane Wilson. *Cable Copyright and Consumer Welfare: The Hidden Cost of the Compulsory License.* Shooshan & Jackson. 1981.

With Harry M. Shooshan III and Jane Wilson. *Newspapers and Videotex: How Free a Press?* Poynter Institute for Media Studies, St. Petersburg, FL. 1981.

"Telecommunications Issues in Transition." *Telecommunications and Productivity*, Mitchell L. Moss, Ed., Addison-Wesley Publishing, Reading, MA. 1981.

"The New Information Technology and the Handicapped: A Guide for Project Selection." Presented to the Joint Seminar of the Foundation Center and the Aspen Institute. Wye Plantation, Queenstown, MD. November 16–17, 1981.

With Daniel S. Allen *et al.* *A Nationwide Communications System for the Hearing Impaired: Strategies toward Commercial Implementation.* Final Report. SRI International, Menlo Park, CA. October 1981.

With Harry M. Shooshan III. "The Battle to Control What You Will Get from Your Computer." *The Washington Post* (Outlook). Washington, DC. August 24, 1980. Adapted from "Home Improvement Center: Newspaper on Television." *St. Petersburg Times* (Perspective). St. Petersburg, FL. June 22, 1980.

"The Allocation of the Radio Spectrum." *Scientific American.* Vol. 242, No. 2. February 1980.

"What Will New Technology Bring?" *Perspectives on Postal Service Issues.* Presented to the Conference on Postal Service Issues. October 13, 1978. American Enterprise Institute. 1980.

EMI EMC Legislation in the 95th and 96th Congress. Proceedings of the 1978 Electromagnetic Interference Workshop. NBS Special Publication 551. U.S. Department of Commerce. U.S. Government Printing Office, Washington, DC. July 1979.

"A Market Alternative for the Orbit-Spectrum Resource." *Proceedings of the Sixth Annual Telecommunications Policy Research Conference,* Herbert S. Dordick, Ed., Lexington Books, Lexington, MA. 1979.

"Reactions to the Spectrum Options Paper." *Proceedings of the Sixth Annual Telecommunications Policy Research Conference*, Herbert S. Dordick, Ed., Lexington Books, Lexington, MA. 1979.

"A View of the Future of Television." Prepared for the Sloan Foundation Conference on Television and Society, Chatham, MA. June 24–30, 1979.

"The Orbit Spectrum Resource—Market Allocation of International Property." *Telecommunications Policy.* Vol. 2, No. 4. September 1978.

"New Technology and the Old Regulation." Prepared for Midcon Professional Program. *Future Alternatives for Communicating with Automobiles.* Dallas, TX. December 12–14, 1977.

Towards Deafnet Policy Problems of Personal Communications for the Deaf. Eascon Proceedings. September 1977.

Improving Use of the Spectrum. Options Papers. House Interstate and Foreign Commerce Committee. Print 95–13. April, 1977.

Technology for Spectrum Markets. Ph.D. thesis. MIT, Department of Electrical Engineering Computer Science. November 1976.

"Electronic Mail." MIT, Center for Space Research. CSR TR–73–2. 1973. Reprinted in Japanese in *Overseas Telecommunications Journal.* Tokyo, Japan. 1976.

Electronic Mail: What Is It? What Might It Be? Presented to the 1976 Telecommunications Policy Research Conference, Airlie, VA. 1976.

Electronic Mail: How Can It Come To Pass? Presented to the 1975 Telecommunications Policy Research Conference, Airlie, VA. 1975.

Spectrum Management in Land Mobile Radio. M.S. thesis. MIT, Department of Electrical Engineering. 1974.

With T. H. Crystal. *Extracting and Processing Vocal Pitch for Laryngeal Disorder Detection.* Presented at the 79th Meeting of the Acoustical Society of America. Atlantic City, NJ. April 1970.

With H. S. Stone. "Structures of the Affine Families of Switching Functions." *IEEE Transactions on Computers*. Vol. C–18, No. 3. March 1969.

Alarm System Using Coded Signaling. U.S. Patent 3,701,019. Describes method for transmitting low-data-rate digital messages with security and message verification.

Review 68–50 of "Multi-Programming System Performance Measurement and Analysis" by H. N. Cantrell and A. L. Ellison. *IEEE Transactions on Computers.* Vol. C–17, No. 11. November 1968.

B. Elspas *et al.* "Properties of Cellular Arrays for Logic and Storage." Stanford Research Institute. Sci. Rept. 3. AFCRL–67–0463. Menlo Park, CA. July 1967.

With R. A. Ankerlin. "A Rapid Method for the Identification of the Type of a Four Variable Boolean Function." *IEEE Transactions on Computers.* Vol. EC–16. December 1967.

SPEECHES/PRESENTATIONS

Dynamic Sharing of Spectrum. Presented at Rutgers WINLab Focus '98. June 1998.

Wireless Networks Opportunities — Challenges Ahead. Presented at the 1998 IEEE Workshop on Multiaccess, Mobility and Teletraffic (MMT'98) for Wireless Communications, Washington DC. October 22, 1998

International Approaches to Telecommunications Restructuring. Presented at the Cross-Industry Working Team Plenary Meeting, Washington, DC. November 4–5, 1997.

Expected Patterns of Product Evolution. Presented to the Twenty-Third Annual Rate Symposium, St. Louis, MO. April 28, 1997.

Panelist. *De-Nationalizing the Airwaves.* First Annual Conference of the Federalist Society's Telecommunications Practice Group: Toward a Free and Competitive Communications Industry, Washington, DC. October 18, 1996.

Improving the Regulation of Public Safety Communications. Presented to the 62nd Association of Public-Safety Communications Officials (APCO) International Conference and Exposition, San Antonio, TX. August 1996.

Telecommunications Deregulation. Presented at the Maryland–District of Columbia Utilities Association's Annual Spring Conference, Ellicott City, MD. April 26, 1995.

Participant in the 11th annual Practicing Law Institute/Federal Communications Bar Association Conference on "Telecommunications Policy and Regulation," Washington, DC. December 10, 1993.

How Auctions Will Work. Presented to the TeleStrategies Spectrum Auctions Conference. Washington, DC. November 1, 1993.

Ensuring Efficient Competitive Outcomes. Presented to the "PCS Summit," Washington, DC. October 13–15, 1993

Carrier Perspectives on Government Investment in Public Telecommunications Infrastructure. Presented to the Computer Science and Telecommunications Board workshop on the Changing Nature of Telecommunications Infrastructure, Washington, DC. October 12–13, 1993.

The Impact and Implications of Changing Technology: Competition in LEC Markets. Presented at the United States Telephone Association Congressional Staff Seminar, Williamsburg, VA. June 3–4, 1993.

Regulation of the Spectrum. Presented to the Industrial Liaison Program Symposium of the Massachusetts Institute of Technology on Universal Personal Communications: Technologies and Policies for Seamless, Digital, Wireless Communications, Cambridge, MA. March 30–31, 1993.

Cost Structure of Competitors. Presented to the Pricing and Costing Strategies for a Competitive Environment. A TeleStrategies Conference, Washington, DC. March 9–10, 1993.

Spectrum Allocation for Personal Communications. Presented to the MIT Communications Forum, Cambridge, MA. February 25, 1993.

Ensuring Efficient Competitive Outcomes. Presented to the Personal Communications Services Conference, Dallas, TX. February 2–3, 1993.

Comments on PCS licenses. Presented to the Wireless Datacomm '92 conference, Boston, MA. December 8–9, 1992.

ISDN. Presented to the Information Gatekeepers, Reston, VA. November 19, 1992.

What Can You Do with a Cordless Telephone? Presented to the Nineteenth Annual Telecommunications Policy Research Conference, Solomons Island, MD. September 28–30, 1991.

Participated in the Congressional Budget Office's (CBO) round-table on the budgetary implications of auctioning new radio frequency licenses, Washington, DC. November 20, 1991.

Moderator. *Personal Communications Services in the '90s.* Annual public relations seminar of the United States Telephone Association—"Public Relations Imperatives For the '90s." Washington, DC. September 13, 1991.

LEC Gateways: Provision of Audio, Video and Text Services in the U.S. Presented to the National Economic Research Associates, Inc., Telecommunications in a Competitive Environment Seminar, Scottsdale, AZ. April 15, 1989. Also presented to the 8th Annual ITS International Conference, Venice, Italy. March 1990.

The Evolution of Access. Presented to the Seventeenth Annual Telecommunications Policy Research Conference, Airlie, VA. October 1–3, 1989.

Open Network Architecture: Definition, Benefits and Costs, Impact on Industry Structure and Performance. Speech presented to the Nineteenth Annual Williamsburg Conference, Williamsburg, VA. December 7–9, 1987.

With Harry M. Shooshan III, Jeffrey H. Rohlfs, and Susan W. Leisner. *The Negative Effects of Tax Reform on the Telephone Industry: Making Up the $15 Billion Difference.* Presented to the Fifteenth Annual Telecommunications Policy Research Conference, Airlie, VA. September 27–30, 1987.

Is Bypass Still a Threat Today? Speech presented to the Telecommunications Policy in a Competitive Environment Seminar, Scottsdale, AZ. March 4–7, 1987.

With Jeffrey H. Rohlfs. *Improving the Economic Efficiency of NTS Cost Recovery.* Presented to the Fifth Biennial Regulatory Information Conference, Columbus, OH. September 3–5, 1986.

With Jeffrey H. Rohlfs. *Improving the Economic Efficiency of Interstate Access Charges.* Presented to the Fourteenth Annual Telecommunications Policy Research Conference, Airlie, VA. April 27–30, 1986.

Remarks presented to The Council of State Planning Agencies, Lincoln, NE. October 20–21, 1985.

Cable and Public Utility Regulation. Speech prepared for the Reason Foundation Conference on Public Utilities, Washington, DC. September 9, 1983.

"Technology Options in Enhanced Services: Twisted Pair to Videodiscs." Comments on *Enhanced Services*. NCTA Executive Seminar Series, National Cable Television Association, Washington, DC. 1981.

The Political Climate for Communications: Gusty Winds from All Directions. Presented to the Energy Bureau, Inc., Washington, DC. December 10–11, 1981.

May 26, 1999

Exhibit 1

EXHIBIT 1

CLEC Switches And Competitively Served Rate Centers In New York Metro